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(71) Applicant
Bijan Jouza
4 Culley View, Alresford, Hampshire, SO24 9PD, United Kingdom

(72) Inventor
Bijan Jouza

(74) Agent and/or Address for Service
Bijan Jouza
4 Culley View, Alresford, Hampshire, SO24 9PD, United Kingdom

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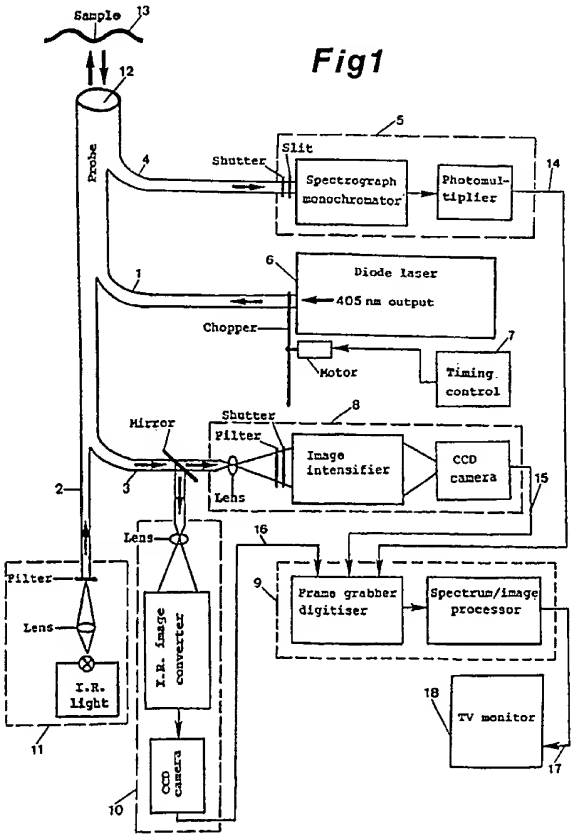
(56) Documents cited
GB 2203813 A **GB 2126717 A** **WO 84/01382 A**
US 4541438 A
Proc. Spie-Intl. Soc. for optical Engineering, vol 1200, pp 466-475 (1990)
Lasers in Life Sciences vol.3. no.2, pp 99-116 (1989).

(58) Field of search
UK CL (Edition K) **G1A ACJ**
INT CL[5] **G01N**
Online databases: WPI and CLAIMS

(54) Photodynamic laser detection for cancer diagnosis

(57) A method and apparatus for detecting the presence of cancerous tissue using fluorescence. The tissue under examination which has absorbed Hematoporphyrin Derivative (HpD) is excited with a beam of coherent light from a diode laser flashed to the body through a fibre optic probe assembly. The fluorescence spectrum and image, as well as normal image from the tissue under examination, are transmitted through the same probe assembly and collected by associated detectors and processor for analysis. The fluorescence spectrum and superimposed normal image and fluorescence image are observed simultaneously on a TV monitor to determine the presence of cancer and its extend, based on the knowledge that the fluorescence spectrum of cancerous tissue is substantially different from normal tissue.

Fig1



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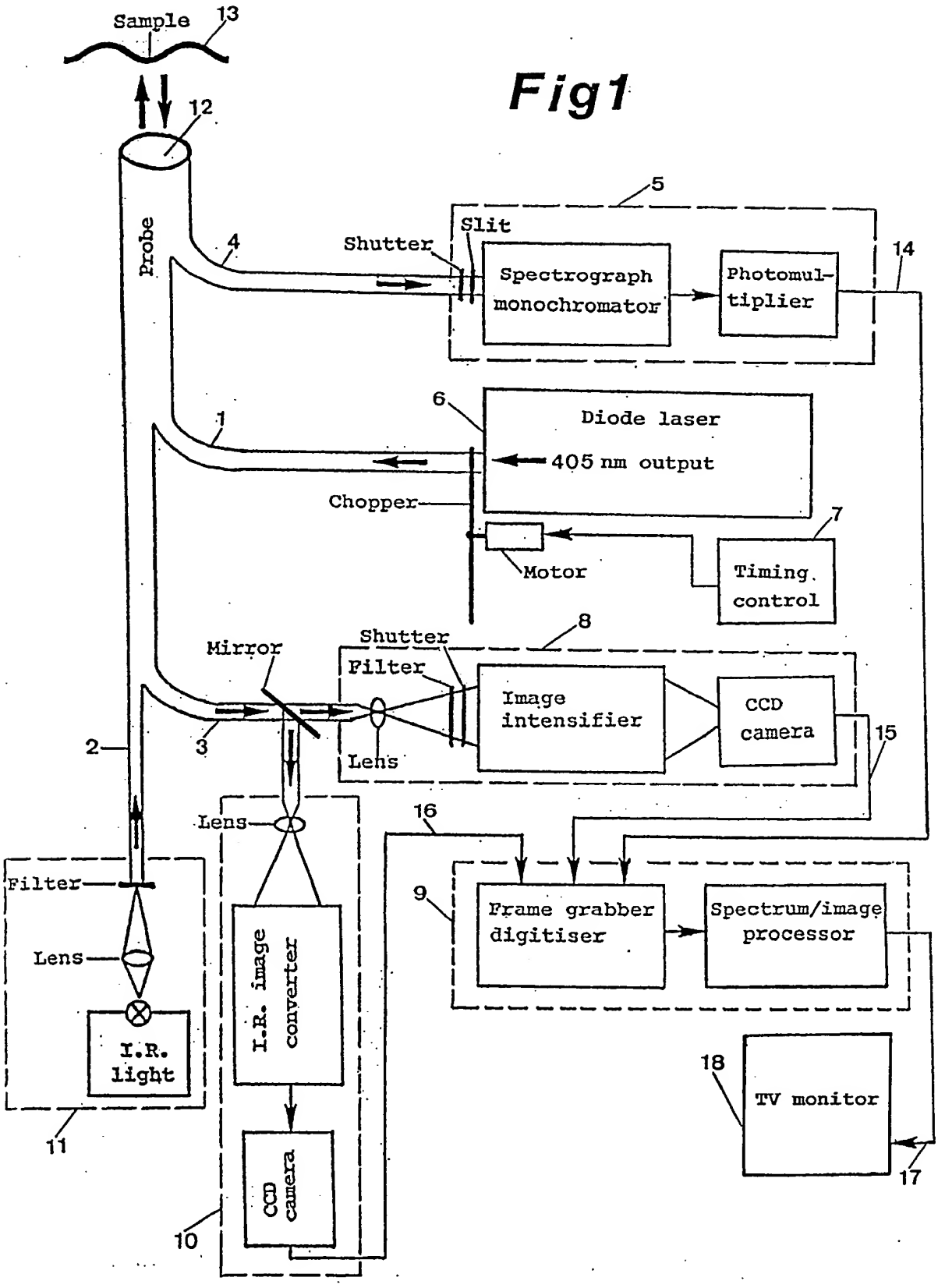


Fig1

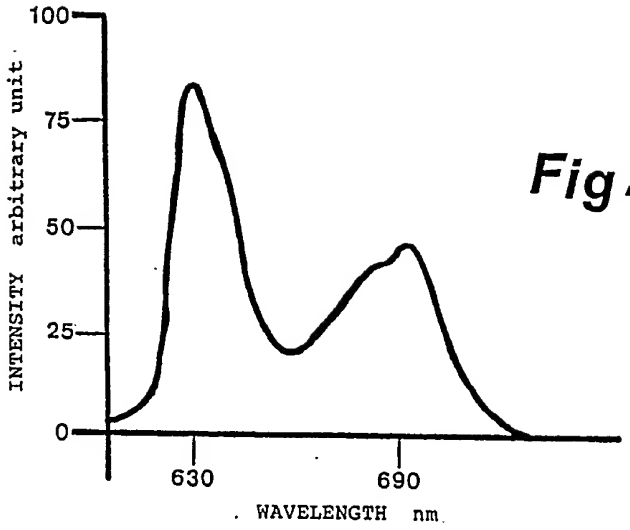
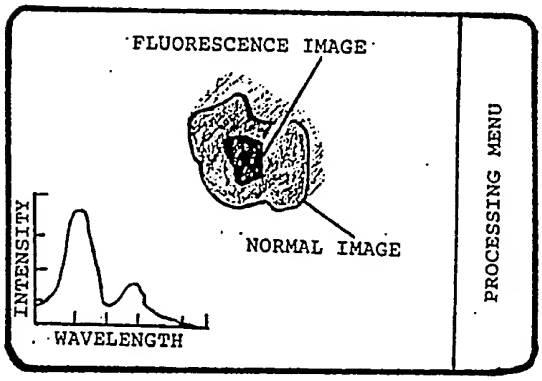


Fig 2

Fig3



PHOTODYNAMIC LASER DETECTION FOR CANCER DIAGNOSIS

The present invention relates to a method and apparatus for detecting the presence of cancerous tissue using fluorescence.

Cancer cells are clonal cells of a single "founder cell", result of some mutation of the normal cell. The founder cell normally replicates and divides as a result of the mutation forming a mass of cells called a "tumour". Tumours can be very harmful to the organism as their proliferation rate surpasses that of the normal neighbouring cells. The tumour growth is at the expense of its normal neighbouring tissue which finally destroys the normal tissue.

The cancer cells disseminate throughout the organism via circulatory or lymphatic systems to create other tumours wherever they arrive. Fortunately in most cases it takes some times before cancer can spread. Clearly the early detection of cancer cells is extremely important for the success of a treatment and the chances of recovery.

At the present, the diagnosis of cancer relies mainly on X-ray, nuclear radiation, magnetic resonance, biopsy and chemical analysis. X-rays and nuclear radiations can cause dangerous side effects and the necessity to reduce or, in some cases, eliminate the use of hazardous radiation is obvious.

The present invention is based partly on the knowledge that the fluorescence spectrum of cancerous tissue is substantially different from normal tissue. Hematoporphyrin Derivative (HpD) is a tumoriphilic photosensitiser which can be injected to the patient intravenously. It emits fluorescence once exposed to light. Therefore making it possible to localize tumour by fluorescence detection.

However useful detection of HpD fluorescence for reliable cancer diagnosis has been complicated and rather expensive.

It is an object of this invention to provide a new improved technique which is rapid and simple, to localize tumour and detect small size cancer approximately 1mm, accurately without involving the use of potentially harmful radiation, such as X-ray, nuclear or ultra-violet radiation.

According to the present invention there is provided a diode laser flashing a beam of 405nm wavelength through a fibre optic probe assembly directed to the body to excite the HpD fluorescence without fluorescence fading and to collect and analyse tissue fluorescence through the same probe assembly and associated spectrum/image detectors and processor.

A specific embodiment of the invention will be described now with reference to the accompanying drawings:

FIGURE 1 is block diagram of Photodynamic laser detection system for Cancer Diagnosis;

FIGURE 2 is graphical presentation of HpD fluorescence spectrum;

FIGURE 3 shows a typical display of fluorescence spectrum and superimposed images.

As shown in Fig. 1, the system consists of a diode laser 6 and doubling crystals delivering a beam of 405nm wavelength. This laser beam is chopped by a chopper producing short laser pulses to avoid fluorescence fading and is flashed to the tissue through optical fibre 1 of the probe assembly 12. A timing device 7 controls the chopper and can vary the rate of laser pulses as required.

Tissue 13 which has absorbed HpD, emits fluorescence with peaks at 630nm and 690nm. The spectrum pattern of the fluorescence is picked up by fibre optic 4 of the probe assembly 12 and transmitted to a spectrograph/ monochromator equipped with a photomultiplier 5. The signal 14 from photomultiplier is fed to a frame grabber/digitiser and the converted analogue to digital signal is fed to the spectrum processor 9. The graphical image of fluorescence spectrum Fig. 2 is displayed on TV monitor 18.

Because white light deteriorates rapidly the HpD fluorescence, for visual inspection, an infrared light source and associated lens and filter 11 is used to illuminate the inspected lesion through fibre optic 2 of the probe assembly 12. An infrared image converter and a CCD video camera 10 collect the normal image of the lesion through the image guide 3 of the same probe 12, and a half reflecting mirror. The normal image 16 is displayed directly on the TV monitor 18 bypassing frame grabber/digitiser and processor 9.

The image guide 3 transmits the weak fluorescence image to an image intensifier and a CCD video camera mounted together with a fibre optic tapper 8. The intensified video signal of fluorescence image 15 is fed to the frame grabber/digitiser and converted from analogue to digital signal and fed to the image processor 9. A pseudo-colour fluorescence image is superimposed on the normal image Fig. 3 on the TV monitor 18. Pseudo-colour help to distinguish between the strongest and the weakest fluorescence, indicating the intensity and exact situation of cancerous region. All spectrum/image processings 9 are controlled by dedicated processing software.

CLAIMS

1 A method and apparatus for detecting the presence of cancerous tissue using a diode laser emitting a beam of 405nm wavelength to excite tissue fluorescence.

2 A method to conduct laser beam of claim 1 through a fibre optic probe assembly for in vivo and in vitro body examinations.

3 A method to visually observe inside or outside a body without deteriorating tissue fluorescence by using invisible infrared lighting and infrared image converter and associated optical lenses and filters through fibre optic probe assembly of claim 2.

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Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

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Relevant Technical fields

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Search Examiner

A J RUDGE

Databases (see over)

(i) UK Patent Office

(ii) Online Databases: WPI and Claims

Date of Search

8 JULY 1991

Documents considered relevant following a search in respect of claims 1-2

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	US 4541438 (JOHNS HOPKINS U) eg column 1 lines 61-8; column 4 lines 16-20	1-2
Y	WO 84/01382 (ONCOLOGY RES DEV.) see whole document	1-2
X	GB 2203813 A (ACAD APPL SCI) eg Claim 1	1-2
X	GB 2126717 A (HAMAMATSU)	1-2
X	Proc. SPIE-Intl Soc for Optical Engineering, vol 1200, pages 466-475 (1990)	1-2
Y	Lasers in Life Sciences Vol 3, No.2, pages 99-116 (1989)	

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

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